THE CRUSHED STONE JOURNAL

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High Lights from the Annual Safety Congress

Industry to Have Trade Practice Conference

SEPTEMBER, 1929

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Why Concrete for Highways Should be Tested for Its Beam Strength

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Director, Bureau of Engineering, National Crushed St one Association .

THE primary object of conducting tests on materials of construction is to determine their suitability for the particular service they must render. If we wished to know the load carrying capacity of a structural steel column we would arrive at very misleading results were we to test that column for its tensile resistance. If we wished to determine the quality of cast iron to be used under flexural conditions we would be quite misled and would obtain very poor information if we merely tested a specimen of that cast iron in compression. In neither case would our tests determine the particular quality desired of the material. Accordingly, to establish a proper test for concrete for highways it is essential that we first inquire into the kinds of service rendered by highway concrete. Then we shall be able to arrive at a logical conclusion as to just what qualities highway concrete should possess and what tests are applicable for determining those qualities.

It is difficult to conceive of any type of concrete structure which is subjected to a more complex set of influences than is a concrete road surfacing. Investigations of the past few years are just beginning to show us something of the stresses to which concrete roads are subjected by the many kinds of forces acting upon them.

Let us consider the concrete road beginning from the day the concrete is laid, and let us look into the many factors which are at work to influence the condition of the surfacing throughout its period of life. The concrete is deposited on the subgrade and slowly hardens. At the very beginning agencies might and in some cases do start to attack the integrity of the hardening mass for it is at this stage that hair cracks develop.

The concrete is "cured" by the use of some means for keeping the surface wet, such as frequent sprinkling and with the use of a wet earth covering, by ponding, by straw covering, and in the last few years by a sprinkling of calcium chloride or by the use of bituminous materials. After a short period of curing, the moisture is allowed to dry out from the concrete, and, as has been well established, shrinkage now takes place and the concrete slab by contraction slowly moves over the subgrade. The forces of friction thus developed between the subgrade and the slab produce tensile stress in the concrete, and when this stress exceeds the tensile strength, transverse cracks form at frequent intervals. Changes in temperature of the slab also expand and contract it and cause it to slide over the subgrade, again producing compressive or tensile stress. During the day, the top surface is heated by the sun to a higher temperature than the bottom surface and naturally the slab is warped downward at the edges and corners. During the night the reverse is true; the corners warp upward. In many cases they actually leave the subgrade. During periods of dry weather, the top surface becomes quite dry, while the bottom surface is in contact with the more or less moist subgrade. Under such conditions the concrete might be warped and bent upward at the sides and ends. In the meantime the varying moisture conditions in the subgrade are swelling and shrinking the soil in a most non-uniform manner and the road is offered non-uniform support. When cold weather comes, the ground freezes. Very naturally the entire road is raised due to the expanding action of the frost, and if it happens that snow is cleared from the center of the road and is heaped up along the sides, the insulating blanket of snow prevents as deep a penetration of frost at the sides as at the center. The center of the road is then heaved more than the sides which overhang their center support like two cantilever beams, and through

over-stress thus created, the slab is cracked down the center. Frost action within the concrete itself also must be resisted, and this requires a dense, strong concrete of low absorption. A number of natural influences then have been at work even before traffic is turned onto the road.

The heavy fast-moving loads of the present day produce high stress in concrete slabs under certain conditions. This is particularly so with heavy fast-moving vehicles having well-worn solid rubber tires. Impact stresses are apt to be high and this is especially true in the vicinity of joints and on roughly finished spots in the road. Not only does this heavy impact produce high bending stress, but the local pressure on the immediate surface is considerable. There are concrete roads in which exceptionally poor coarse aggregates have been used largely as a matter of expediency, and these are now showing signs of distress from the action of traffic.

When we add to all of these influences the troubles which are apt to occur due to the use of unsuitable materials, too much water, or greatly inferior workmanship, coupled with a design ill-adapted to the conditions of subgrade and traffic, the wonder is that concrete roads are capable of giving the most excellent service which, in general, they are giving under our present day rubber tired traffic.

It will be noted in the above discussion that considerable emphasis is laid on the high bending and high tensile stress to which road concrete is subjected almost from the day it is laid. The possibility of high compressive stresses also makes it imperative that we inquire into the relative magnitude of the compression and tension and then inquire further as to the ability of the concrete to resist these respective stresses.

No theoretical proof is needed of the inability of plain concrete to resist the bending stresses of traffic when unusually non-uniform conditions of subgrade support exist. This insufficiency of concrete to bridge wide, non-supported areas or to resist tension is amply demonstrated in practice and the visible evidence is the frequent cracks seen in many concrete surfaces.

Let us, however, consider these poor subgrade conditions to be abnormal and curable, then let us examine the internal stress when the pavement is laid on a reasonably uniform pavement support. It is recognized, of course, that this is an optimistic assumption, for uniformity of pavement support seldom exists and consequently the slab is frequently not adequately supported.

The main stress producing agency in concrete pavements is traffic and the heavy wheel loads of traffic give us most concern. When a heavy wheel rolls over the pavement that portion under the wheel is bent down and the concrete is forced to assume a curved shape and consequently the concrete is subjected to bending stress. Actual measurements of the shape of the curve or of the amount of the strain produced in the concrete under the action of wheel loads have been taken by the U. S. Bureau of Public roads at Arlington, also by the Illinois State Highway Department and by the Bureau of Public Roads in cooperation with the Pennsylvania State Highway Department in a test road near Harrisburg, Pa. All of these tests demonstrated that high bending stresses are produced in concrete roads by the heavy wheel loads of traffic, especially at the edges of the slab.

The actual bending and stress effects are best shown in Figs. 1 and 2.

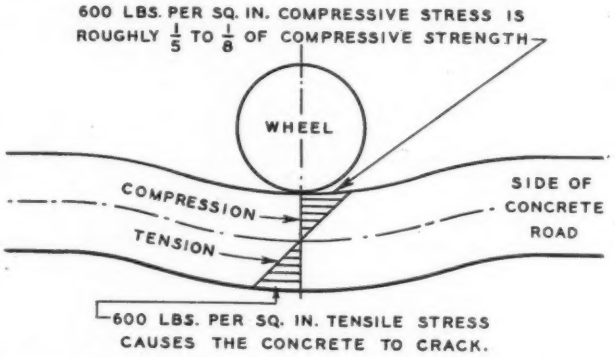
600 LBS. PER SQ. IN. COMPRESSIVE STRESS IS ROUGHLY 1/5 TO 1/8 OF COMPRESSIVE STRENGTH
WHEEL
COMPRESSION
TENSION
SIDE OF CONCRETE ROAD
600 LBS. PER SQ. IN. TENSILE STRESS CAUSES THE CONCRETE TO CRACK.

FIGURE 1.—THE COMPRESSIVE AND TENSILE STRESSES ARE EQUAL.

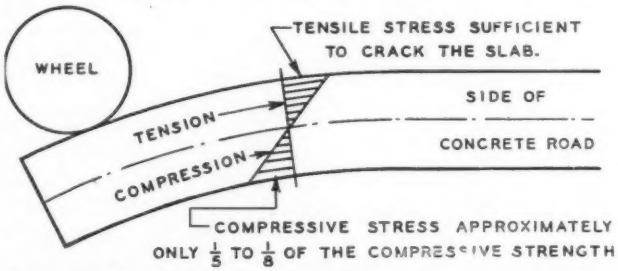
TENSILE STRESS SUFFICIENT TO CRACK THE SLAB.
WHEEL
TENSION
COMPRESSION
SIDE OF CONCRETE ROAD
COMPRESSIVE STRESS APPROXIMATELY ONLY 1/5 TO 1/8 OF THE COMPRESSIVE STRENGTH

FIGURE 2.—THE COMPRESSIVE AND TENSILE STRESSES ARE EQUAL. WHEN THE TOP OF THE SLAB HAS CRACKED THE COMPRESSION SIDE OR BOTTOM OF THE SLAB IS ONLY MODERATELY STRESSED IN COMPRESSION AND IS ENTIRELY SAFE AGAINST THE POSSIBILITY OF A COMPRESSION FAILURE.

The above figures demonstrate in exaggerated form the shape assumed by the side of a concrete road when it is bent under traffic. Fig. 1 represents the conditions when the wheel load is placed at the side of the slab at some considerable distance from an expansion

joint or crack. Here horizontal tension is produced on the bottom of the slab and horizontal as well as vertical compression occurs at the top of the slab immediately under the wheel.

In Fig. 2 the wheel is placed along the side of the slab at a corner such as might occur at an expansion joint. Here, the horizontal tension occurs on the top of the slab and a like amount of internal horizontal compressive stress is produced at the bottom under the bending action of the load.

The important point to notice in the stress diagram shown by the shaded double triangular area is that, owing to the bending of the slab, the amount of horizontal tension is almost identical with the horizontal compression. This fact is highly significant because it shows that, under beam or bending action, the road cannot fail due to a lack of compressive resistance, for concrete is from 5 to 8 times as strong in compression as in tension. Hence, since the tensile and compressive stresses due to bending are about equal, failure must always take place on the tension side of the slab. Lack of tensile resistance and not lack of compressive resistance is the cause of cracking in concrete under wheel loads.

Is Compression Ever Important in Highway Concrete?

Is it possible to have compressive stresses in highway concrete which are of sufficient magnitude to cause the concrete to crush? One is apt to think that the heavy wheel loads of motor trucks must surely produce high vertical compression under these loads. But when it is remembered that solid rubber tires are incapable of giving adequate service when the pressure intensity on them exceeds to any extent the 800 pounds per inch of tire width generally permitted by law, it will be seen immediately how very insignificant this vertical compression really is. Even if the entire 10,000 pound rear wheel load of a heavy truck were concentrated on a 12-inch tire over a strip only one inch in width, the compressive stress in the concrete would be only slightly in excess of 800 pounds, whereas highway concrete is capable of withstanding over 3,000 pounds per square inch in compression. Actually, instead of having a surface contact of only one inch, a 12-inch solid rubber tire flattens out so that it has an area of contact with the pavement 12 to 15 inches long by 12 inches wide. Thus the actual tire pressure is only a few hundred pounds per square inch. Vertical compressive stress from tire pressure can be ignored; it is of very low value.

Can high compression be produced from expansion due to temperature and moisture? The answer is, yes, it can, but failure of the pavement takes place under such conditions due to "blow-ups" and when a pavement "blows up" a tension failure occurs due to high bending stresses. Possibly it is conceivable that high enough compression may occur to shatter a pavement unaccompanied by "blowing up" but this action is extremely rare and is entirely eliminated by proper design to allow for expansion through the provision of expansion joints of sufficient thickness and frequency. High longitudinal compression due to expansion thus may be looked upon as a negligible factor in its effect on the longevity of road concrete. Especially is this so when the concrete has high beam strength, for, as will be shown later, *concrete having high beam strength will also have sufficiently high compressive strength but, on the other hand, it does not not always follow that concrete having high strength in compression will always have high enough strength in flexure or cross-bending.*

Meaning of the Term "Modulus of Rupture"

The bending strength of concrete is measured in terms of its so-called "Modulus of Rupture" and it is important that the meaning of this term be understood. In Fig. 3 is shown a simple beam loaded at the center.

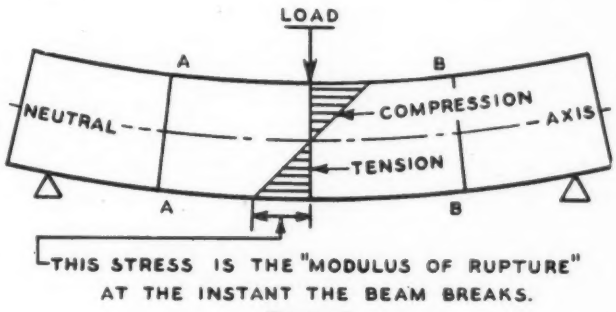

FIGURE 3.

It bends down under the action of the load and if we drew parallel lines on the side of the beam before loading, we would find that after loading, these lines would assume the position shown by lines AA and BB. The tops of the lines will have come together and the bottoms will have spread apart, thereby showing that the top of the beam has shortened and the bottom has lengthened. When any material shortens, internal compression is created and similarly when a material is stretched internal tension must exist. There is a surface in a beam where neither tension nor compression exists. This is known as the neutral plane and

in a rectangular beam it is coincident with the center line of the beam. The greater the load, the greater will be the internal bending stresses and these stresses are greatest at the extreme top and bottom of the beam. Finally, the load reaches an amount which causes failure and the greatest tensile stress existing in the beam at that instant is the so-called "modulus of rupture." It is calculated by well known methods derived from the principles of mechanics which need not be discussed here. It is expressed in pounds per square inch.

Illustrations of the Lack of Uniformity of the Relation of Beam Strength to Compressive Strength

It has been stated by some investigators that there is a well defined relation between compressive strength and transverse strength of concrete and that the all important factor in controlling either of these strengths is the so-called water-cement ratio, that is, the ratio of volume of water to volume of cement in the mixture. It is all too commonly thought that the water-cement ratio is the only factor which controls the compressive or transverse strength of concrete. As a matter of fact there are a number of other factors which also control the strength of concrete.

The ratio of volume of water to volume of cement used, merely controls the strength of the cement paste —the glue which holds the aggregate together. Certainly there are still other factors to be considered, principal among which are:

a. The characteristics of the particular cement used.
b. The absorption of the aggregate.
c. The surface characteristics of the aggregates—whether smooth and polished or rough.
d. The strength of the aggregates.

All of these things affect the compressive strength irrespective of the original amount of water used in the mix to create a given consistency and still more do they have a very decided effect on the transverse strength. It is these factors, all too commonly overlooked, which make for different strengths in concrete. It is also these factors which seem to have an accenuated influence on beam strength.

The results of a series of tests on concrete conducted by the laboratory of the National Crushed Stone Association have already been published[1] and the compressive strength and modulus of rupture values obtained in these investigations are shown in Fig. 4. These tests were made with aggregate whose qualities varied over a wide range. Some of them were siliceous gravels having polished, smooth surfaces, others were limestone gravels, and still others, gravels having exceedingly weak and friable fragments. The crushed stones

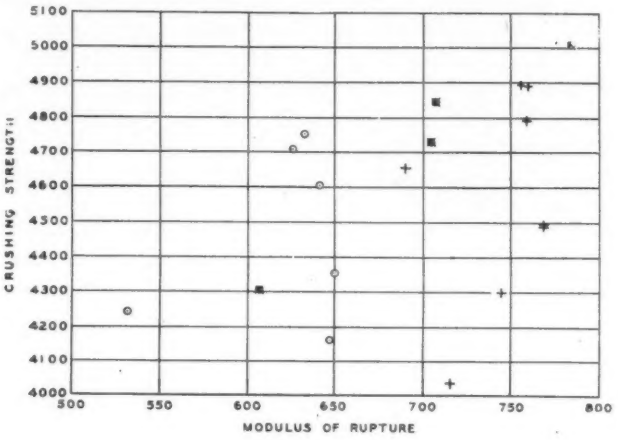

FIGURE 4.

came from deposits of trap rock, granite, quartzite, marble, limestone and dolomite. Thus, commercial aggregates varying over a wide range were included.

Referring to Fig. 4 in which are shown the compressive and transverse results of the above mentioned tests, it is quite obvious that all of the compressive strength values are amply high for they exceed 4,000 pounds per square inch. Yet the modulus of rupture values vary from only 531 to 786 pounds per square inch and the greatest value is 48 per cent higher than the least. It is also very evident that there is no relation between compressive strength and modulus of rupture shown by these tests. High compressive strength does not insure a high value for modulus of rupture.

In Fig. 5 are reproduced the strength results obtained in a very comprehensive series of tests made at the U. S. Bureau of Public Roads, on a wide variety of aggregates, and published in "Public Roads," June, 1929. Comparing the upper curve for modulus of rupture with the lower curve for compressive strength, it is seen again that there is no relation at all between compressive strength and modulus of rupture, when different aggregates are used. The highest values for modulus of rupture are not obtained with concrete giving the highest compressive strength. Also, it is obvious that low compressive strength may not result in low transverse strength but may actually be accompanied by exceedingly high transverse strength.

[1]See March and June, 1929, Issues of The Crushed Stone Journal.

Recognition of the Importance of Beam Strength in Theory for Concrete Road Design

That high beam strength is important rather than high compressive strength is recognized in such theory as has been developed for the design of concrete roads to carry heavy wheel loads. This theory in its simplest form takes into account the fact that a very undesirable condition exists in a concrete road when it becomes broken into comparatively small slabs. One of the conditions creating the highest stress occurs when a wheel load is placed at the corner of a road slab, whether that corner be at the side of the road or an interior corner formed at the juncture of longitudinal with transverse cracks or joints.

When a wheel load is so placed there is always the danger of bending down the corner due to the lack of supporting value of the subgrade and the consequence is that high tensile stresses may be produced at the top of the slab. If these stresses are high enough to equal the modulus of rupture of the concrete, a crack is formed and the corner is broken off from the main body of the slab. Deterioration of the slab may ensue with great rapidity because impact then results due to the depression of the broken corner into the subgrade. Unevenness is thereby developed, as amply demonstrated by the impact tests of the U. S. Bureau of Public Roads. Stresses are set up under the wheel load which may greatly exceed those due to the mere static weight of the vehicle.

The formula for calculating the required thickness of a road slab at the edge most generally used is:

$$d = \sqrt{\frac{3W}{S}}$$

Where d = thickness of slab at the edge.
W = wheel load.
S = the safe unit stress on the tension side of the slab.

It is to be noted that nothing whatever is mentioned in the formula regarding the compressive strength of the concrete, for those who derived the theory have recognized the established fact that the compressive strength of the concrete is of no importance as compared with its tensile strength or resistance to bending.

When we make a beam test the value for modulus of rupture thus obtained determines what is the safe value to use for the quantity "S" in the above formula. In other words, by making a beam test we determine

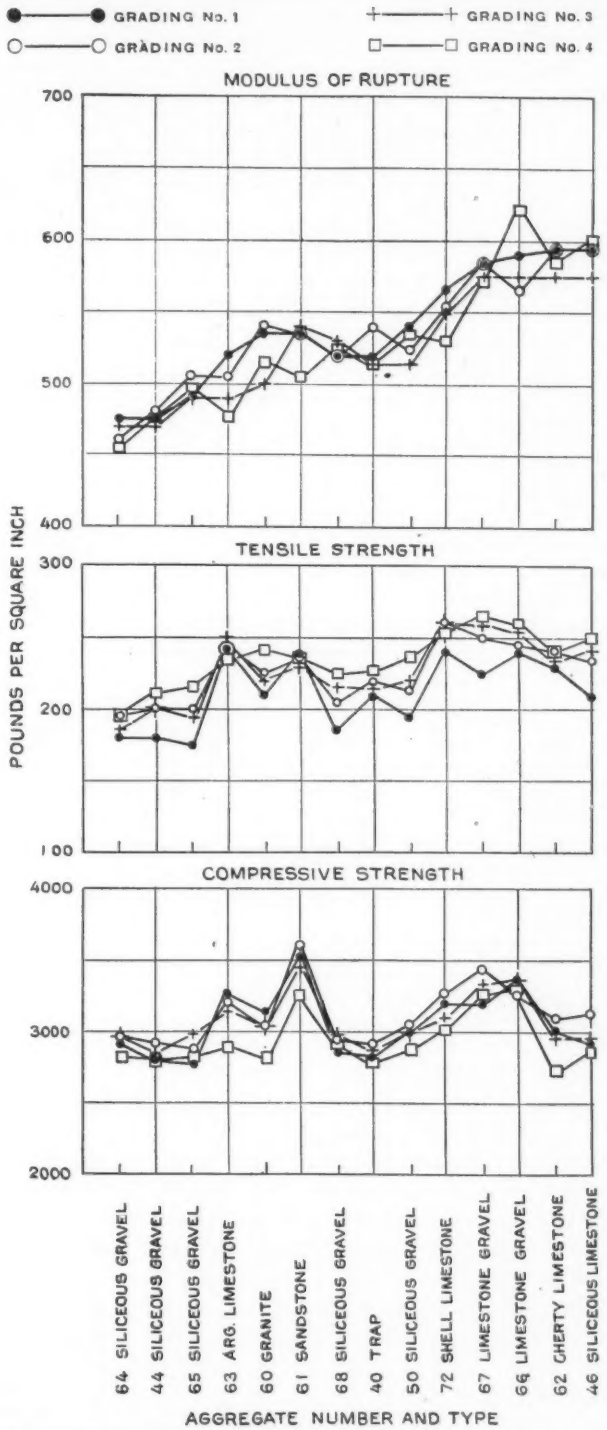

FIGURE 5.—RESULTS OF STRENGTH TESTS ON EACH GRADING AVERAGE FOR FOUR MIXES

the very property of concrete with which we are directly concerned and this property can by no means be determined accurately enough by the use of a compression test.

Safe Value for the Quantity "S"

Concrete highways are subjected to loads which are repeated time and again with the passage of motor vehicles. The heavily traveled road may be subjected to thousands of applications of heavy wheel loads durthe course of a single year and to hundreds of thousands of lighter wheel loads. It is this fact which makes our selection of the right quantity to use for the quantity "S" a very important matter, and it is also this fact which makes it highly important that road concrete have as high a value in cross-bending as it is feasible to obtain, economically.

Repeated load tests have been made on concrete beams at Purdue University, by the State Highway Department of Illinois, and elsewhere, and it has been ascertained that concrete suffers fatigue and is weakened under the continuous application of loads with the result that, after a large number of repetitions a concrete beam will break under a load which would not break it were the load applied only once instead of thousands of times. It seems to be the case that if the load is of such magnitude as to stress the beam to more than half the value of its modulus of rupture, that beam will fail in a comparatively short time under that load. On the other hand, if the same beam is loaded with a somewhat smaller load, so that the stress produced is a little under one-half of the value of its modulus of rupture, for all practical purposes the beam will bear that load, applied repeatedly, almost indefinitely. This leads us to a method for determining what value we must use for "S" in the above formula for designing concrete road slabs.

It is commonly assumed that the value for "S" should be approximately one-half of the modulus of rupture of concrete. Probably, to be somewhat more on the safe side, it would be better to use an even smaller value for "S" than one-half of the modulus of rupture which would result in a somewhat thicker slab. It is a matter of common observation that concrete roads made with some aggregates crack much more frequently and at a much earlier period of time than those made with other aggregates and a very likely explanation of this phenomenon seems to offer itself in lack of bending resistance. It has been pointed out that if the bending stress produced by wheel loads is only slightly in excess of one-half of the modulus of rupture of the concrete, that concrete will be rapidly fatigued and will break under the wheel load producing that stress. On the other hand, if the stress produced is less than one-half of the modulus of rupture of the concrete, no breaks will occur, for the slab is capable of bearing up under these repeated loads applied hundreds of thousands of times.

As a typical illustration, consider two of the cases shown in Fig. 4, one concrete having a modulus of rupture of 531 and the other of 745. The safe unit stress to use in the design formula in each of these cases would be 531 divided by 2, or 265 and 745 divided by 2, or 372. Suppose these two concretes formed contiguous sections of the same highway and were subjected to the same traffic. If that traffic, time and again produced a bending stress of 300 lbs. per sq. in. in the concrete, the weaker concrete would be affected in a comparatively short time, whereas the stronger concrete should be unaffected by the traffic loads. The reason is that the 300-lb. stress produced by the wheel loads is in excess of the stress which should be allowed on the weaker section, namely 265, whereas the 300-lb. stress produced is less than the stress of 372 allowable in the stronger section; the weak section would be fatigued rapidly and the strong section would suffer little fatigue. Yet, as has been pointed out, these same concretes both have high compressive strength and judging from their compressive strength results alone, both concretes might be considered equally good.

It is frequently over-looked by highway engineers that their concrete highways are built with almost no factor of safety. That is to say, the stress produced under wheel loads very frequently approaches the stress allowabie in the pavements. The consequence is that if a concrete slab is weaker in cross-bending than necessary to withstand frequent repititions of heavy wheel loads, rapid failure ensues. Is any further statement needed to convince the most skeptical highway engineer that the all important quality of highway concrete is not high compressive strength but high beam strength? If high beam strength is obtained, the engineer need have no fear of the ability of the concrete to resist the compressive stresses which will be developed, for such stresses will be comparatively small and, moreover, the concrete high in beam strength will also be high in compressive strength, although the reverse is not true.

Design of Concrete for Beam Strength

The engineer who contemplates using beam strength as his criterion of the quality of highway concrete may raise the point as to the possibility of designing con-

crete mixtures to produce the beam strength desired. It has been shown that the characteristics of the coarse aggregates, and it follows also that the characteristics of the cement and fine aggregates, all have a part in influencing beam strength. Consequently, no general theory which may be set up will apply to individual materials any more than the general water-cement ratio theory applies to individual materials. However, the following method is entirely feasible and will insure the production of concrete roads having uniform beam strength.

Procedure in Design of Concrete for Beam Strength

1. First it is necessary to determine the shape of of a modulus of rupture-water cement ratio curve or curves typical of the materials proposed for use.

2. Determine the 7-day beam strengths of concrete made of the particular materials under consideration, using an assumed water-ratio, as close as possible to that which will finally be used.

3. Draw a curve through the 7-day strength result parallel with the established modulus of rupture-water cement ratio curve and thus determine the actual water-cement ratio necessary to give the desired strength with the particular materials which will be used on the job.

4. Make a trial batch of concrete using the necessary water-cement ratio from which the necessary proportions are determined.

5. These proportions will serve to set the mix in the field, which may be altered as the job proceeds and as the necessity for this is indicated by the field beam specimens, and by the workability of the concrete.

The above procedure is entirely feasible and has the advantage of leading definitely to concrete of a strength which the engineering department has set up as the value requisite for the particular purpose of the road being built. Concrete roads are made of a given thickness with the idea that they will thus be capable of carrying the wheel loads of traffic to which they are subjected. Mere thickness does not insure that they will be of sufficient strength but if, in addition to the required thickness, the concrete also has the required modulus of rupture, the desired strength of the road for adequately supporting the traffic is assured. Without a knowledge of the modulus of rupture, on the other hand, the engineering data is incomplete and there is no assurance whatever that the road will be capable of carrying the traffic.

Counties Are Building Higher Type Highways

REPORTS obtained by the Bureau of Public Roads, U. S. Department of Agriculture, from authorities of selected counties indicate a tendency toward a higher type of local and county road construction in the United States. With each succeeding year the percentage of graded and drained earth roads decreases and the percentage of surfaced roads increases, says the bureau, on the basis of the reports.

The reports indicate that there was improved in 1928 in the entire United States, exclusive of State roads, a total of 45,531 miles of local and county roads, of which 29,888 or 66 per cent were surfaced, and 15,643, or 34 per cent were graded and drained earth roads. In 1927, the estimated mileage improved was 59,732 miles, of which 33,852 or 57 per cent was surfaced and 25,880 miles or 43 per cent was graded and drained. In 1926, the total mileage improved was 89,026, of which 36,027 miles, or 41 per cent, was surfaced, and 52,999 miles, or 59 per cent, was graded and drained.

The surfaced roads constructed in 1928, indicated as 29,888 miles, are made up of the following types of pavement: Sand-clay and topsoil, 3,518 miles; gravel, 20,221; water-bound macadam, 3,001; bituminous macadam, 1,631; sheet asphalt, 83; bituminous concrete, 267; Portland cement concrete, 1,145; and 22 miles of brick and other block pavements.

At the end of 1928 the estimated total length of county road systems was 2,709,839 miles, according to the figures given to the bureau. Of this total, 432,999 miles are surfaced, with the following types of pavement: 74,562 miles of sand-clay and topsoil, 277,797 miles of gravel, 46,454 miles of water-bound macadam, 14,953 miles of bituminous macadam, 1,472 miles of sheet asphalt, 3,763 miles of bituminous concrete, 12,317 miles of Portland cement concrete, and 1,681 miles of brick and other block pavements.

The angularity of crushed stone is an important asset. This quality is the basis for the high stability of crushed stone railroad ballast, traffic bound and bituminous types of roads. It also accounts for the exceptionally high beam strength of crushed stone concrete, a property of great value in pavements.

Changes in Present Method of Calculating Depletion Allowances Are Proposed

THE question of proper allowances for depletion is one of direct interest to crushed stone producers in the determination of operating cost. Therefore, readers of THE CRUSHED STONE JOURNAL will be interested in three new methods for the determination of depletion allowances in computing Federal taxes predicated upon a fixed rate per unit, on the basis of a percentage of gross income, and also upon a percentage of net income basis, which have been proposed in a preliminary report made public by the Joint (Congressional) Committee on Internal Revenue Taxation. The report has been ordered printed for information and discussion, but has not yet been considered or approved by the members of the committee.

It is the opinion of H. R. Stutsman, Income Tax Counsel for the National Crushed Stone Association, that no drastic changes, or any changes which may be less beneficial to the industry than the present basis of computation, will be forthcoming. However, as the subject is of such direct importance to crushed stone producers, it has been considered desirable to give the industry full information regarding the present method of calculating depletion and the scope of the proposed changes.

The discussion of the subject of depletion—outlining the general situation, the defects in the present system of computation, and the methods proposed for the consideration of the Joint Committee—which appears in this article is taken from the preliminary report of the Chief of Staff to the Joint Committee on Internal Revenue Taxation, under the chairmanship of Representative Willis C. Hawley.

The valuation of all natural resources for depletion purposes has been required under every revenue act since 1916, with the exception of relatively few cases in which depletion is based on the cash actually paid for the property. The difficulties confronting the Bureau of Internal Revenue in the valuation of natural resources are almost insurmountable. Various causes may be assigned for this. In the first place, the methods of valuation adopted permit of wide discretion in individual judgment. The result is differences of opinion even with respect to the same properties. Many actual cases exist in which experienced engineers have differed in their reports on the same property by at least 400 per cent. In the second place, the date of valuation is so far removed from the date as of which the examination must be made that it is practically impossible to secure sufficient evidence to determine a correct valuation. In the third place, the turnover of personnel and the magnitude of the undertaking have added to the difficulties.

1. No Constitutional Limitation

The Constitution does not require that the property owner be given any allowance for depletion. The Supreme Court has held that this deduction is not one to which he is entitled as a matter of right, but is a concession made by Congress in recognition of the equity in such cases.

In U. S. v. Ludy (274 U. S. 295) the Supreme Court reached the following conclusion as to the meaning of depletion:

> The depletion charge permitted as a deduction from gross income in determining the taxable income of mines for any year represents the reduction in the mineral contents of the reserve from which the product is taken. The reserves are recognized as wasting assets. The depletion effected by operation is likened to the using up of raw material in making the product of a manufacturing establishment. As the cost of the raw material must be deducted from the gross income before the net income can be determined, so the estimated cost of the part of the reserve used up is allowed.

2. Accounting Concepts of Depletion

From an accounting standpoint, the proper basis for determining depletion is the cost of the property. This basis is not recommended because of the apparent hardships resulting from its application.

There is no appreciable difference between the legal and the accounting concepts of depletion. It is a fundamental principle of accounting that no profit is realized from a sale unless all elements of the cost of the product are deducted. In the case of the sale of natural resources one of the important elements of cost is

the price paid for the raw material. In accounting terminology this deduction for the cost of the raw material is called depletion. The usual accounting procedure is to set aside in a reserve an amount out of the sale of each unit of the product sufficient to equal the entire cost of the raw material when exhaustion of the mine or other natural resource takes place. For example, the unit of depletion for each ton of coal sold in the case of a mine containing 1,000,000 tons and costing $100,000 is 10 cents per ton.

3. Statutory Provisions

The existing law provides for five different bases for determining depletion, namely: cost; March 1, 1913, value; discovery value; 27½ per cent of gross income; and 50 per cent of net income.

(*a*) *Prior acts.*—The corporation excise tax law of 1909 failed to provide for any deduction on account of the depletion of mineral reserves. The resulting hardships to operators of mines induced Congress to make provision in the first income tax law for depletion. The revenue act of 1913 provided for a reasonable deduction for depletion in the case of mines (interpreted by the Bureau of Internal Revenue to include oil and gas wells). The amount of the deduction, however, was limited to 5 per cent of the gross value, at the mine, of the output for the year. The revenue act of 1916, in effect, adopted the provisions of the prior act except for a change in the limitation of the allowance. In lieu of the limitation prescribed in the prior act, a limitation based upon the market value in the mine of the mineral sold was substituted. The revenue act of 1918 broadened the scope of depletion to include other natural deposits and timber. The latter act placed no specific limitation on the amount of depletion allowable and further broadened the basis of depletion by providing for an allowance based upon cost, March 1, 1913, value if the property were acquired prior to March 1, 1913, and discovery value in the case of mines, oil and gas wells, if made subsequent to March 1, 1913. The revenue act of 1921 reenacted the provisions of the revenue act of 1918, but limited the amount of depletion on discovery value to the net income from the property. The revenue act of 1924 embodied the provisions of the last act, but further limited the amount of depletion on discovery value to only 50 per cent of the net income from the property.

(*b*) *Current act.*—The current law authorizing an allowance for depletion is the revenue act of 1928. The provisions of this act are the same as those contained in the revenue act of 1926. These provisions, in substance, are as follows:

1. In the case of timber and surface deposits depletion is allowable on cost or March 1, 1913 value. No discovery depletion is allowable.
2. In the case of mines depletion is allowable on cost, March 1, 1913 value, or fair market value on or about the date of discovery (if discovery is made after March 1, 1913). The discovery depletion, however, is limited to 50 per cent of the net income from the property (computed without allowance for depletion).
3. In the case of oil and gas wells depletion is allowable on cost, March 1, 1913 value, or, in lieu of either, 27½ per cent of the gross income from the property. The amount in the last instance, however, is limited to 50 per cent of the net income from the property (computed without the depletion allowance).
4. For gain or loss on the sale of property, or for the computation of net loss carried forward to subsequent years, depletion is allowable on cost or March 1, 1913 value.

4. Methods of Valuation in Use

Three methods are employed by the Bureau of Internal Revenue in valuing properties for depletion: (1) Comparative sales method, (2) prevailing royalty method, and (3) analytic appraisal method.

Comparative sales method.—The comparative sales method consists of determining the fair market value of the property as of the basic date of valuation by reference to the average price paid for similar properties on or about that date. The following hypothetical example shows the practical application of this method:

A gravel deposit on March 1, 1913, contains 100,000 tons. A similar deposit containing 50,000 tons sold in January, 1913, for $1,000, or at the rate of 2 cents per ton. Another deposit of similar character containing 100,000 tons sold in June, 1913, for $2,500, or at the rate of 2½ cents per ton. The average price paid per ton in the two comparative cases is 2¼ cents. The March 1, 1913, value of the first-mentioned gravel deposit is, therefore, 2¼ cents times 100,000 tons, or $2,250.

Prevailing royalty method.—Properties operated under lease contracts are often valued by determining the present worth of the savings indicated by the difference between the prevailing royalty rate and the actual royalty rate paid. The prevailing royalty rate is found by an examination of the rates paid in the case of leases of similar properties executed at or near the basic date of valuation. The following computation of an actual case makes clear the application of the principles involved in this method.

A coal lease calling for a royalty of 10 cents per ton was estimated to contain, as of March 1, 1913, 4,031,500 tons. It was estimated, also, that the average annual output would be 335,958 1/3 tons. The predicted life of the property, therefore, was 12 years. Royalties paid on or about March 1, 1913, as evidenced by contracts on similar properties, provided for a rate of 17.9 cents per ton. The saving, therefore, under the terms of the lease is 7.9 cents per ton, or an annual saving of $26,540.71 (.074 times 335,958 1/3). The present worth of the annual savings of $26,540.71 for 12 years, computed at 8 per cent is $200,116.92. The depletion unit is, therefore, $200,116.92 (the present worth of the lease) divided by 4,031,500 (the estimated tonnage), or $0.04966 per ton.

Analytic appraisal method.—This method, as the title suggests, is an analytic appraisal of the ore in the mine on the valuation date, and is based on the principle of finding the present worth of the future expected profits. In fact, the method is known, also, as the present worth method, as the future expected profits method, and as Hoskold's method. It is the method most frequently employed by the Bureau of Internal Revenue in the case of metals. Like the prevailing royalty method, the first step in valuing the properties is to estimate the number of units of mineral in the mine, and the second step is to estimate the average annual rate at which it will be removed. Unlike the preceding method, however, the valuation does not follow mathematically from these two estimates. Other perplexing steps are required.

It is necessary, as the third step, to estimate the cost to mine the ore and to determine the percentage of metal recovery from the ore. Fourthly, the cost of adequate plants to be constructed during the life of the properties must be estimated. Finally, the future selling price of the metal must be predicted from statistics of actual sale prices for a reasonable period prior to the valuation date and from the exercise of judgment as to the probable trend of prices in the future. The above difficult estimates having been made, the expected profit is determined by deducting from the estimated sale price of the mineral the estimated cost of production. This expected profit is now reduced to present worth by a special discount table, prepared by H. D. Hoskold, an engineer of international reputation on mine valuations. (See Engineers Valuing Assistant, by H. D. Hoskold). In finding the value of the ore for depletion purposes, as a final step it is necessary to deduct from the present worth of the total expected profits the value of the present and future plants as of the basic date. The following example taken from the Bureau of Internal Revenue records will elucidate the practical application of this method:

A mining property on March 1, 1913, is estimated to contain 3,811,924 tons of ore, and the annual rate of extraction is estimated to be 254,128 tons, giving an expected life of 15 years to the mine. The ore is estimated to contain 15.734 pounds of copper per ton, resulting in a total content of recoverable copper of 59,976,212 pounds, the production cost of which is estimated to be 10 cents per pound. The average future selling price of copper is predicted to be 15.12 cents per pound. Therefore, the operating profit per pound is 5.12 cents. Multiplying this operating profit per pound by the total number of pounds of recoverable copper, the total expected profit is found to be $3,070,782. By Hoskold's table, using an interest rate of 8 per cent and a sinking fund rate of 4 per cent, the present worth of this total profit is found to be $1,575,474 as of March 1, 1913. To find the value of the ores only, the March 1, 1913, value of the plant, $500,000, is subtracted from the present worth, leaving $1,075,474 as the value of the ores. The rate per pound allowed for depletion is found, of course, by dividing the value of the ores ($1,075,474) by the estimated amount of recoverable copper (59,976,212 pounds), resulting in a depletion rate of 1.793 cents per pound.

5. Defects in the Present System

(a) *Administrative.*—The administrative defects under the present system are (1) lack of uniformity in computing depletion, due to the exercise of individual judgment; (2) lapse of time between the basic date and the examination of the return; (3) inability to secure sufficient evidence to establish a correct valuation; and (4) excessive expense to both Government and taxpayer.

(*b*) *Instability of revenue.*—Under the present system, the depletion deduction is allowed before arriving at net income. In lean years the present depletion allowances practically wipe out the tax of this industry, in spite of the fact that substantial dividends are paid. On the other hand, in prosperous years high taxes are collected. As a result, the revenue received from the industry as a whole is more unstable than in the case of the other industries. This appears undesirable from a practical revenue standpoint.

(*c*) *Inequitable results.*—There are many inequitable results in the present system. The different laws relating to depletion as applied to the different industries are not uniform. The oil and gas industry is allowed percentage depletion based upon gross income before the depletion deduction is computed. The ef-

fect of this allowance is to vary the deduction in proportion to the gross receipts from the sale of these products. Contrasted with this are the allowances based on a March 1, 1913, or a discovery value, in which cases the depletion varies with the quantity produced. Finally, in certain limiting cases, depletion is allowed on the basis of a percentage of the net income from the property. The valuation methods applied by both the Bureau of Internal Revenue and the taxpayer are not uniform and produce many inequalities between different industries. Valuations by the widely used analytic appraisal method depend largely on the peculiar conditions existing as of the basic date. These peculiar conditions appear to have little to do with an equitable tax on annual income. For example, taxpayers who make discoveries in periods of prosperity are allowed large deductions for depletion, whereas those who are so unfortunate as to make discoveries in years of depression are required throughout the life of the property to take a lower rate.

6. Method Proposed for Consideration

Several methods for computing depletion are proposed for consideration. They are as follows: (*a*) Fixed rate per unit method, (*b*) percentage of gross income method, and (*c*) depletion based on percentage of net income, consisting of plans (1) and (2). Both the fixed rate per unit method and the percentage of gross income method involve a wide departure from the allowance authorized by existing law and appear to produce inequities in the case of certain industries. Plan No. (1) of the percentage of net income method is based upon a percentage of net income from the property and is similar to the method adopted by Canada. Plan No. (2) is based upon a percentage of net income adjusted so as to allocate a reasonable amount of such net income to plant investment. This last plan when applied to concrete cases appears to produce more equitable results than the first plan.

7. Advantages of Net Income Method

The percentage of net income method has many advantages. It will result in (*a*) elimination of discovery depletion, (*b*) simplification of administration, (*c*) partial elimination of March 1, 1913, valuations, (*d*) stability of revenue from this source, and (*e*) correction of inequities between different industries as well as between taxpayers in the same industry.

The principal advantages of the method of percentage depletion based on net income over the other methods considered are as follows:

(1) Percentage depletion has a relation to the value of the ore as does the present method, whereas the fixed rate method and gross income method have no relation to such value.

(2) The change in method will, therefore, be less disturbing in effect than other methods proposed.

(3) This method is simple in its application and eliminates the many factors of speculation and uncertainties entering into present methods of valuation.

(4) It requires but one computation for depletion whereas the gross income method with the 50 per cent limitation requires two computations; and

(5) It eliminates March 1, 1913 value, and discovery value, as a basis for percentage depletion.

(6) The method has proved to be practicable in the application of the Canadian income tax law. That country uses a method similar to plan No. 1 in the case of metal mines and a fixed rate per unit of products sold in the case of coal mines. The Canadian system for depletion allowances may be briefly described as follows:

1. Gold and silver mines, 50 per cent of the net income.

2. Copper, lead, and zinc mines, 25 per cent of the net income.

3. Oil and gas wells, 25 per cent of the net income.

4. Coal mines, 10 cents per ton.

It appears that Canada allows more depletion to gold, silver, and coal mines than this country. Less depletion is allowed, however, to copper, lead and zinc mines.

8. Conclusion

This report shows that the present system for determining depletion is neither simple in its application nor equitable in its results. The present system is not only inequitable between taxpayers in the same branch of the mining and quarrying industry, but the distribution between the different branches is unjust. For example, bituminous coal mine operators have not received the relief given other mine operators. The coal industry has been profitable only in a few years and

is now in a condition as depressed as agriculture. The present system results in taking away from the bituminous coal industry a large proportion of its profits in taxes in the infrequent year of prosperity. It appears, therefore, that a substitute method is desirable.

This report proposes several substitute methods for discussion. While the report indicates a preference for plan No. 2, a method of percentage depletion based on the net income from the property, it is hoped that the other methods will also receive careful analysis. In order to limit the scope of the discussion to the determination of a sound general method, certain subsidiary propositions like net losses, distribution of depletion between lessor and lessee, etc., are not considered. If a sound method can be devised, the related minor problems can readily be solved.

It is believed that if any plan of computing depletion is adopted based on a percentage of net income from the property, that both March 1, 1913, depletion and discovery depletion should be eliminated if substantial simplification is to result. It should be added in this connection that the argument has been advanced that it will be exceedingly difficult to determine the net income from the property. This argument does not appear to be supported by actual facts. The existing law, namely, section 114 (b) (2) of the revenue act of 1928, requires such a determination by providing that the allowance for discovery value in the case of mines shall not exceed 50 per cent of the net income of the taxpayer from the property. Limitations of somewhat similar character are contained in the revenue acts of 1921, 1924, and 1926. During the many years that this requirement has been in the law, no complaint has been made that the net income from the property could not be determined. Furthermore, many operators of mining companies admit that the method of bookkeeping employed by mining companies will show the net income from this source without difficulty.

Sufficient data is not available for fully testing the operation and effect of the methods proposed. It is hoped that this report will stimulate such interest in the subject that the Bureau of Internal Revenue, as well as the taxpayers affected, will make a thorough test of these methods by applying them to actual conditions.

Quarry Accidents Decrease in 1928

A TOTAL of 119 employes were killed and 10,568 injured in the quarrying industry of the United States during the calendar year 1928, according to a statistical survey made by the United States Bureau of Mines, Department of Commerce. The death rate for the industry was reduced 10 per cent and the injury rate 20 per cent below the 1927 level, when 135 workers were killed and 13,459 injured.

In the quarrying industry 89,667 men were employed by 1,436 active operators. The number of men employed was 1,850 less than in the preceding year. A total of 24,397,377 man-days of labor was performed. The fatality rate per thousand 300-day workers was 1.46, while the injury rate was 129.95.

The quarrying of limestone required the services of the largest group of workers, 37,830; cement rock quarries employed 22,315; granite, 11,314; marble, 6,777; trap rock, 3,908; standstone and bluestone, 3,849; and slate, 3,674. The highest accident rates were in the trap-rock group, in which 9 fatalities and 591 injuries occurred, the fatality and injury rates being 3.13 and 205.78 per thousand 300-day workers, respectively. In the large group of limestone workers, 60 men were killed and 5,399 injured, the fatality and injury rates being 1.84 and 166.02. Of the cement rock workers, 25 were killed and 1,161 injured, the fatality and injury rates being 1.05 and 47.76. In the granite group, 11 were killed and 1,713 injured, the rates being 1.17 and 181.48. At the marble quarries seven employes were killed and 718 injured, with fatality and injury rates of 1.08 and 110.38. In the sandstone and bluestone group 3 men were killed and 473 injured, with fatality and injury rates of 1.02 and 160.50. In the slate group 4 were killed and 513 injured, with fatality and injury rates of 1.24 and 158.87.

The greatest single cause of death in and about the quarries was falls or slides of rock or overburden, which accounted for 29 fatalities. Falls of persons caused 11 fatalities; machinery, 10; explosives, 9; hauling, 8; electricity, 3; handling rock at face, 2; flying objects, 2; drilling and channeling, 2, and boiler and air-tank explosions, 1. The largest single cause of all classes of injuries in and about quarries was handling rock at the face, which accounted for 1,400 accidents. In outside work, machinery was responsible for 9 fatal injuries, haulage and falls of persons for 8 each; burns for 6; electricity for 4; falling objects for 3; flying objects for 1, and other causes for 3.

High Lights from the Annual Safety Congress

THIS started out to be an account of what happened at the Quarry Section meetings at the Eighteenth Annual Safety Congress, held at the Hotel Stevens in Chicago, September 29 to October 4, 1929. However, so many reported important progress in reducing accidents and gave so much pertinent detail as to just how it was all done that no article of permissible length could possibly cover it all. Instead we will try to give in a general way what seemed to us the most valuable lessons to be drawn from the great mass of material contributed at the Congress.

We will not confine our comments to the Quarry Section alone. Much of what we say could apply almost as well to any other industry represented at the Congress, because in a very real way the problems we in the crushed stone game must solve in reducing accidents are the same as those any other industry must deal with. All of which is merely another way of saying that accident prevention is chiefly a matter of organization, personnel and the will to do. Special knowledge is helpful, but since most accidents come from the every-day work done in a less than careful enough way, they are to be prevented chiefly by the use of care and intelligence every day in every way on every bit of work done.

Accidents Show Distinct Decrease

As compared to previous congresses there was a distinctly more positive feeling that industrial accidents are definitely on the decrease, and that not only can accidents be greatly reduced but that they can mostly be eliminated. From every branch of industry one heard inspiring accounts of not only important reductions in accidents but often their almost complete elimination. Size of plant or organization seems to have little bearing. Every organization can do it, as is proved by the number that are doing it.

It Pays to Reduce Accidents

Another significant fact was the repeated emphasis on the savings and profits of accident elimination. A fine spirit of appreciation of safety work from the humanitarian viewpoint was evident but we all know that there is nothing quite so effective as an incentive to the sustained systematic effort necessary in eliminating accidents as the good old balance sheet. Man after man testified as to the financial benefits of a high standard in accident prevention. The direct savings are usually not nearly as large as the indirect ones. Such things as better methods of doing work, better cooperation, better trained personnel, increased loyalty and the discovery and elimination of waste that are usually incidental to accident prevention work usually outweigh by many times the direct savings possible. One experienced executive, whose accident prevention record is most enviable, stated that he thought these incidental profits and economies were at least ten times the direct ones. That is, a quarry with a direct cost of $1,000 for compensation, medical, first aid, time lost from accidents, and the direct accident costs could profit $10,000 a year by performance reasonably close to the elimination of accidents, that is by making such records as are not at all rare now in the crushed stone industry.

The Big Boss Is Keynote to Suceess

The difference between half-hearted safety work and the kind of sustained effort that brings results was illustrated by a talk given by Thomas J. Quigley, Chief of the Quarry Section, Dept. of Labor and Industry of Pennsylvania. He told how one company of Pennsylvania had reduced in its eight quarries its total of accidents causing loss of time beyond the day on which the accident occurred from 207 in 1927 to 108 in 1928 and to 29 in the first nine months of 1929. In this case, the improvement was due to the direct interest taken by the President of the company. Before he became interested to the point of spending personal time and effort on it, his organization, and, of course, himself, wanted safety, did the more obvious things, and talked a good deal about it, but they didn't realize that accident prevention must be made an intimate part of the every day duties of every employe from the highest to the lowest. The President finally realized this, and as head of the company furnished the necessary intelligent forceful drive to bring his entire organization to see the matter clearly and to cause them to cooperate in eliminating accidents. All of which is convincing proof of the fact that the management must take an

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Industry to Have Trade Practice Conference

MUCH has been read in the press of recent months regarding trade practice conferences, and the very beneficial effects which these conferences are having upon the industrial life of the United States.

The crushed stone industry has now joined the rank and file of other industries who have decided to enlist the aid of the Federal Government in eliminating the many uneconomical and unfair practices which exist in industry today.

It will be remembered that the first steps taken towards this end were instituted by President Graves before the Cleveland Convention last January, when he spoke as follows:

"We should construct and individually sign a code of trade practice reciting those ethical things we thereby agree to do and enumerating unethical practices from which we are obligated to refrain. While idealists have long held that such a code of ethics was of spiritual and moral value to an association or industry, it is only quite recently that it has made any strong appeal to the practical mind as being worth any more than the paper upon which it is written. The practicality has entered through the doors opened by the Federal Trade Commission, which has been seeking to stimulate the proper growth and development of trade associations and indicating to them those things which are lawful, and assisting them to avoid those in conflict with our Federal statutes. Such an attitude on the part of the Commission marks a new era in business relationships. If the members of this Association, representing, as they do, some sixty to seventy per cent of the tonnage produced annually by the entire industry, should agree, through the guidance and counsel of the Federal Trade Commission, upon a code of trade practice, certain provisions thereof would be enforceable at law by the Commission. To others it would give its moral force expressed in persuasion, letting fall upon an offender, if not legal action, the heavy weight of adverse public opinion. So are idealism and practicality merged, as they should be."

The next step was the appointment of a Trade Practice Committee by President Wise, with Mr. Graves as its chairman. This committee, during the first six months of the year worked tirelessly and energetically in cooperation with the United States Chamber of Commerce, and representatives of the Federal Trade Commission in promulgating a code of trade practices or resolutions which it was thought would be acceptable to the crushed stone industry, and which would eliminate uneconomical and unfair trade practices under which the industry is at present operating.

The results of the vigorous efforts of this committee were made public to the Association through the Report of the Trade Practice Committee, which was presented to and approved by the Board of Directors at its semi-annual meeting in July, and which was subsequently published in the July issue of *The Crushed Stone Journal*. Immediately following the meeting of the Board at Atlantic City, the Federal Trade Commission was asked to call a trade practice conference for the crushed stone industry to be held at the Hotel Gibson, Cincinnati, Ohio, on January 23, 1930, which is the day immediately following the last day of the annual convention of the Association. We have just been advised that the Federal Trade Commission has authorized a trade practice conference of the industry to take place on the date as suggested above. Invitations to attend the Conference will be sent out by the Commission in the very near future to all crushed stone producers of the United States.

The practices which have been condemned by the resolutions referred to above are acknowledged by all to be burdensome upon our industry. They continue

to exist largely because no individual or small group of individuals feel that they can take the first steps towards the elimination of such practices, unless assured that their competitors will do likewise. A trade practice conference provides the only possible solution so far devised for overcoming this difficulty.

The success of the conference unquestionably depends upon the measure of cooperation with which this movement will be accepted by the individual crushed stone producers throughout the United States. Unanimity of action will be the keynote of success. It is obligatory upon each and every individual producer to inform himself fully regarding the resolutions which will be acted upon at the conference, and to come to the conference clothed with the necessary authority to act for his company when the various resolutions are proposed for adoption. We most earnestly suggest, therefore, that every crushed stone producer again most carefully read the proposed resolutions as given in the July issue of *The Crushed Stone Journal*, and forward such comments as may occur to him, pro or con, to Mr. Otho M. Graves, Chairman, Trade Practice Committee, General Crushed Stone Co., Drake Bldg., Easton, Pa.

Through the medium of the trade practice conference, the Association is afforded the opportunity of cleaning its own house, without interference by the Federal Government but with its whole-hearted cooperation. It will indeed be unfortunate if through lack of interest or understanding our trade practice conference does not measure up to the success which similar conferences have attained in other industries. The responsibility lies upon us as individual executives of plants making up the crushed stone industry, and our earnest plea is that this responsibility be immediately assumed to the end that a full representation of the industry may be present at the conference next January.

Inventor of Stone Crusher Receives Recognition

IT will be a most pleasant and gratifying surprise to the crushed stone industry to learn that after 77 years, suitable recognition is to be given to the inventor of the first automatic stone crusher. The citizens of New Haven, Connecticut, have decided to erect a bronze tablet in the suburb of Whitneyville, commemorating its invention by Eli Whitney Blake, which has contributed so largely to the rapid development of building and highway construction.

Contrary to the honor accorded his uncle, Eli Whitney, inventor of the cotton gin, Eli Whitney Blake received but little attention outside of the immediate industrial circles where his invention was responsible for such decided savings in time and money.

Events which lead to the invention of the first crusher are perhaps of more than passing interest. Mr. Blake had been appointed a member of a committee to superintend the resurfacing of Whally Avenue, and in view of the limited appropriation available, he was impressed with the cost of labor for crushing stone. The inventive strain that marked the Whitneys soon bore fruit with the result that in a few months the first automatic stone crusher was ready to function.

When the crusher was first placed in operation it attracted widespread interest, people from miles around driving in carriages to New Haven to witness the event.

Unfortunately Mr. Blake never received financial reward for his invention. During his latter years he wrote a book entitled "Original Solutions of Several Problems in Aerodynamics," which gave him momentary prominence in scientific circles.

Independence Bureau to Assist in Accident Prevention

THE Committee on Accident Prevention has obtained the services of Independence Bureau to aid and advise in the organized accident prevention work of the Association. Many of you know Independence Bureau. They are a firm of consulting engineers specializing in accident prevention and fire prevention. It is by working along lines advised by them that some notable records in accident prevention have already been made by members of the Association.

Independence Bureau has played a real part in the remarkable work of the Portland Cement Manufacturers Association in eliminating accidents, because at the start of the work, Independence Bureau was employed by the Portland Cement Association to guide them along lines giving the greatest promise of results desired.

The Committee believes that this connection, whereby organized work of this Association will have Independence Bureau guidance and whereby individual members of the Association will call upon Independence Bureau for professional services, will be of great value to all.

High Lights from the Annual Safety Congress

(*Continued from page* 13)

active interest in the work of eliminating accidents if the best results are to be had. The big boss on top must act as the main spring, or at least he must see that there *is* a main spring, and that it is kept at work. He may give the job to another or to a committee, but both persistent forceful effort, and the authority to act must be always on the job and functioning.

Mr. Quigley summed this truth up strikingly when he remarked that too many big bosses had wish bones instead of back bones.

Attendance at the Quarry meetings was fair, but if our industry realized how valuable these meetings are, and how worth while these Safety Congresses are as a whole, there would have been many times the attendance there actually was. The value of talking with many men from all parts of the country and in other industries as well as ours who are meeting and solving the infinitely varied problems of the safety game cannot be over estimated. And there is a lot of fun in it too. We earnestly suggest that you start planning *now* to attend the next National Safety Congress of 1930. If you don't find the time and money well spent, the treats will be on us.

FLEXCO
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These well known fasteners stop trouble with elevator and tight butt conveyor joints. They have far more strength than needed and the pull is equalized on both sides of the belt insuring long service. Note recessed plates which embed in and compress the belt instead of pulling against the bolt holes. Stocked by leading jobbers in 5 sizes. Consultation invited.
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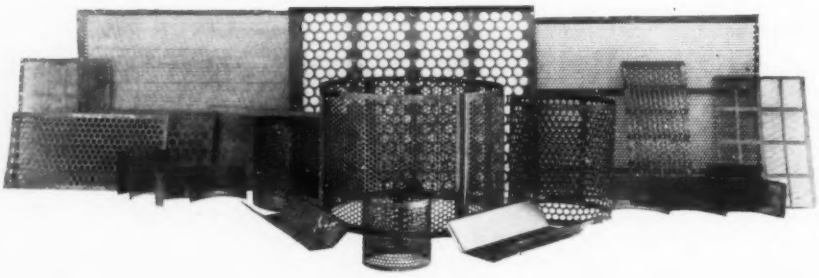

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Trade Practice Conference Authorized

The Federal Trade Commission has recently announced that a

TRADE PRACTICE CONFERENCE

for the entire

CRUSHED STONE INDUSTRY

will be held at the

HOTEL GIBSON, CINCINNATI, OHIO

January 23, 1930

Invitations to participate in this conference will shortly go forward from the Commission to every crushed stone producer of the United States.

The conference will consider and act upon resolutions (previously published in the July, 1929, issue of "The Crushed Stone Journal"), designed to eliminate uneconomic and unfair practices now prevailing in the crushed stone industry.

Each and every crushed stone producer of the United States should have a representative present at this conference with full authority to act.

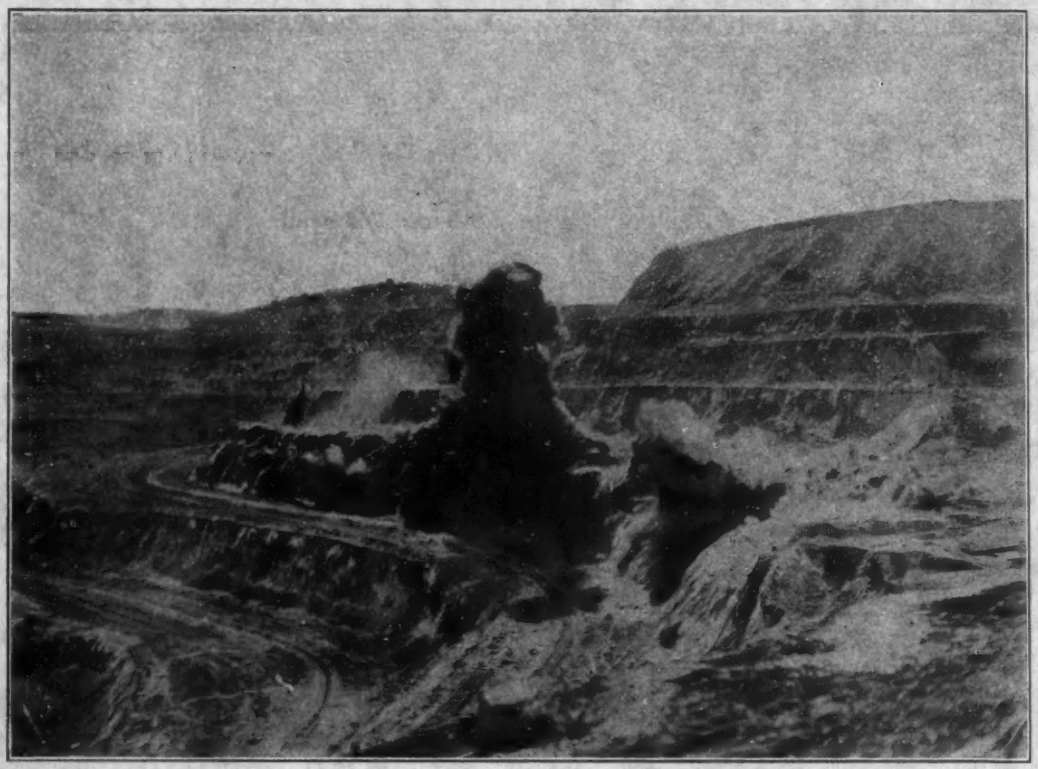
The conference date has been set for the day immediately following the last day of the annual meeting of the National Crushed Stone Association, and will be held at the same hotel. An excellent opportunity is thus afforded members of the industry to attend these two outstanding events of the year with a minimum of inconvenience and expense.

For further information apply to

NATIONAL CRUSHED STONE ASSOCIATION

Merchandise Building, Fourteenth and S Sts., N. W.

WASHINGTON, D. C.



What Practical Quarry Men Think of Cordeau-Bickford

From time to time expressions of opinion regarding CORDEAU-BICKFORD come in from the trade and comments are made in articles. Some quotations from such sources are as follows:

"We prefer CORDEAU as it is safer and the chances of misfire are practically nil."

"We use considerable of your product every year and results obtained are entirely satisfactory."

"We have been using CORDEAU-BICKFORD for a number of years and are glad to state that our experience with it has been very satisfactory and believe that it results in reducing our cost of blasting."

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